



SWISS HARMONY

In Tune with Nature



Swiss Harmony

Real-world fuel economy test of CarTuner on passenger car

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Executive summary



- Increase in fuel economy of 3.9% on the combined cycle – statistically significant
 - Strongest effect seen in urban operation, up 4.6% on average – statistically significant
 - The extra-urban results showed smaller uplifts with lower significance, but still a positive result
 - Consequently, there is a 3.7% reduction in carbon dioxide – statistically significant
 - Carbon monoxide down 36% – statistically significant
 - Nitrogen oxides down 9.0% – statistically significant
 - Nitrogen dioxide down 2.4% – not statistically significant overall
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- Positive result on this vehicle, which is a high selling model
 - Further testing would be required to make general claims across the vehicle fleet

OBJECTIVE

Objective

- To assess the fuel economy benefits of Swiss Harmony's CarTuner product on a single EU type approved passenger car
- To determine the effect on CO₂ greenhouse gas emissions
- To determine the effect on CO pollutant emissions
- Additional analysis of NO_x and NO₂ subsequently provided



METHOD

Test plan

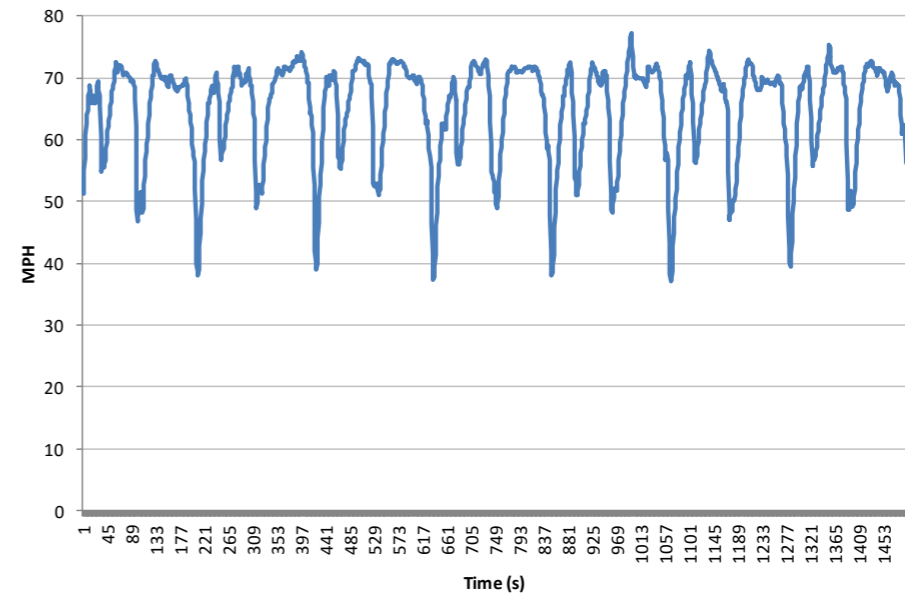
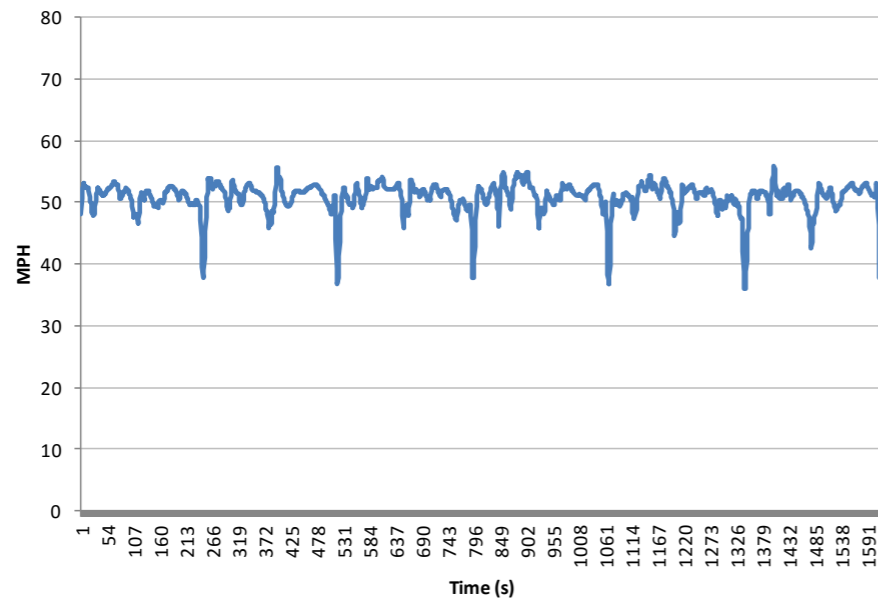
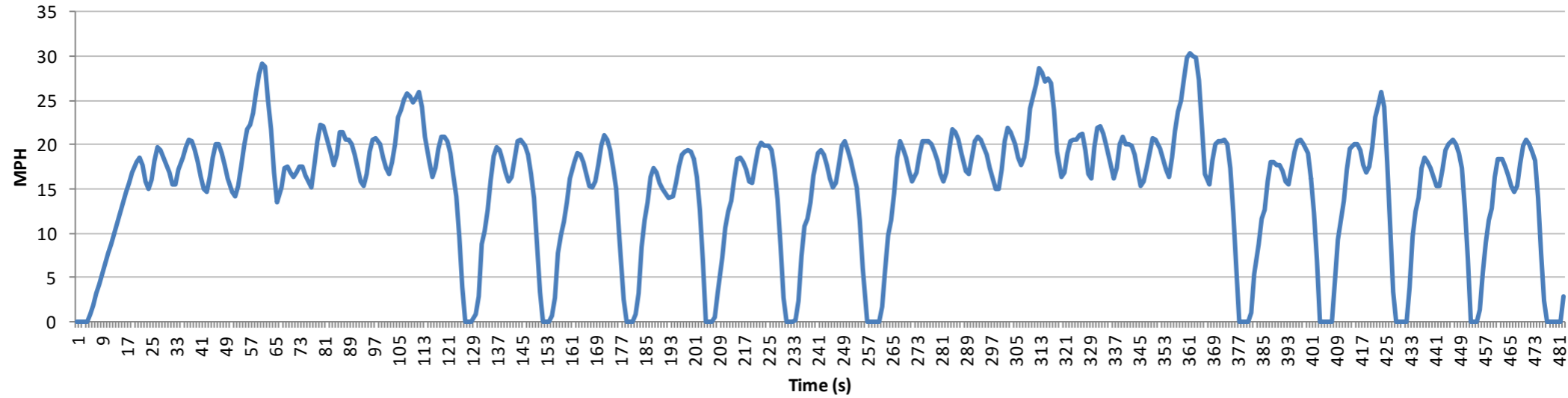
- Location: Bruntingthorpe Proving Ground, Leicestershire, UK
- Dates: 23 to 24 November 2015

- Receive and inspect vehicle
- Create tailpipe connection
- First test
- CarTuner installation
- Second test
- Restore tailpipe and return

Test protocol

- Warm up cycle
- Test cycle:
 - 3.5 km urban cycle at average speed of 22 kph
 - 6.1 km rural cycle at average speed of 78 kph
 - 6.1 km motorway cycle at average speed of 104 kph
- Repeat complete cycle multiple times during each test
- Match climatic conditions for first and second tests as closely as possible

Test cycle



Data capture

- CO₂ and CO from gas analyser (NDIR)
- NO and NO₂ from gas analyser (NDUV)
- Hydrocarbons from gas analyser (FID)
- MPG derived using carbon balance method
- Speed and altitude from GPS
- Temperature, humidity and pressure from independent weather station
- Engine data via CANBUS
- Time aligned

Analysis

- Each test phase broken down into multiple sub-samples
 - To prove repeatability
 - Mean and standard deviation of sub-samples calculated
 - Outliers eliminated
- Any weather-affected repeats removed
 - Initial rural and motorway repeats after installation discarded
- Fuel economy results normalised to reference cycle
- “Comparison of means” method used to assess whether statistically significant change after installation
 - 1-tailed test as only testing for improvement
- Combined cycle made up of weighted average of urban (50%), rural (25%) and motorway (25%)

VEHICLE

Vehicle: FE14 ZTF

- Vauxhall Insignia
- CDTi Elite Nav
- Hatchback
- Diesel
- Year of manufacture: 2014
- Engine size: 1956cc
- Official CO₂ emissions: 140 g/km
- 2 wheel drive
- 6-speed automatic
- Miles on odometer: 34547 at start



EQUIPMENT

Equipment

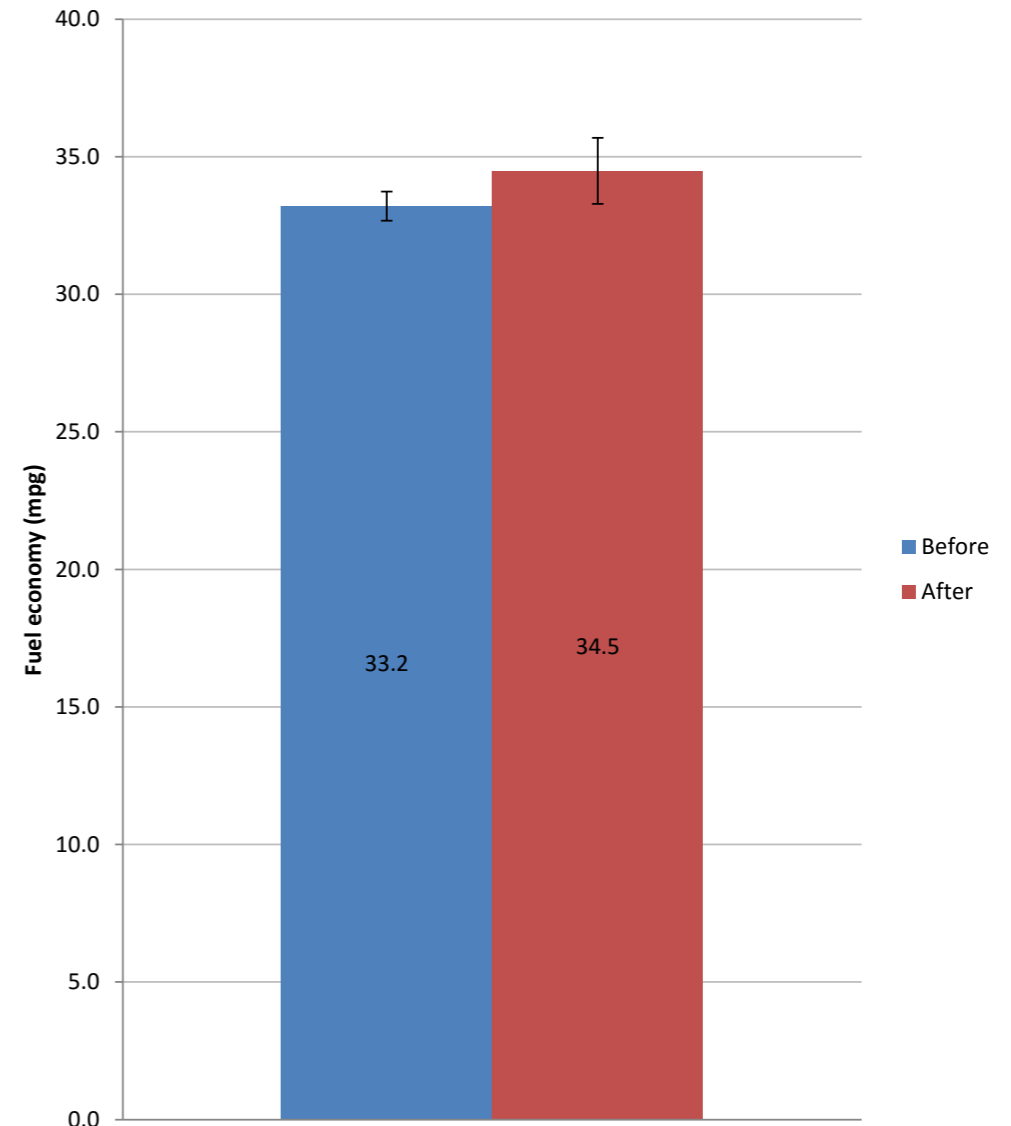
- Laboratory-grade equipment
 - Precision of 2-3%
- Portable Emissions Measurement System connects to tailpipe
 - Captures emissions for CO₂, CO, NO, NO₂, total hydrocarbons
 - At 1 Hertz
- Air temperature, pressure, humidity
- GPS for speed and altitude
- Engine data via CANBUS
- Weights approximately 95kg if running with auxiliary batteries



RESULTS

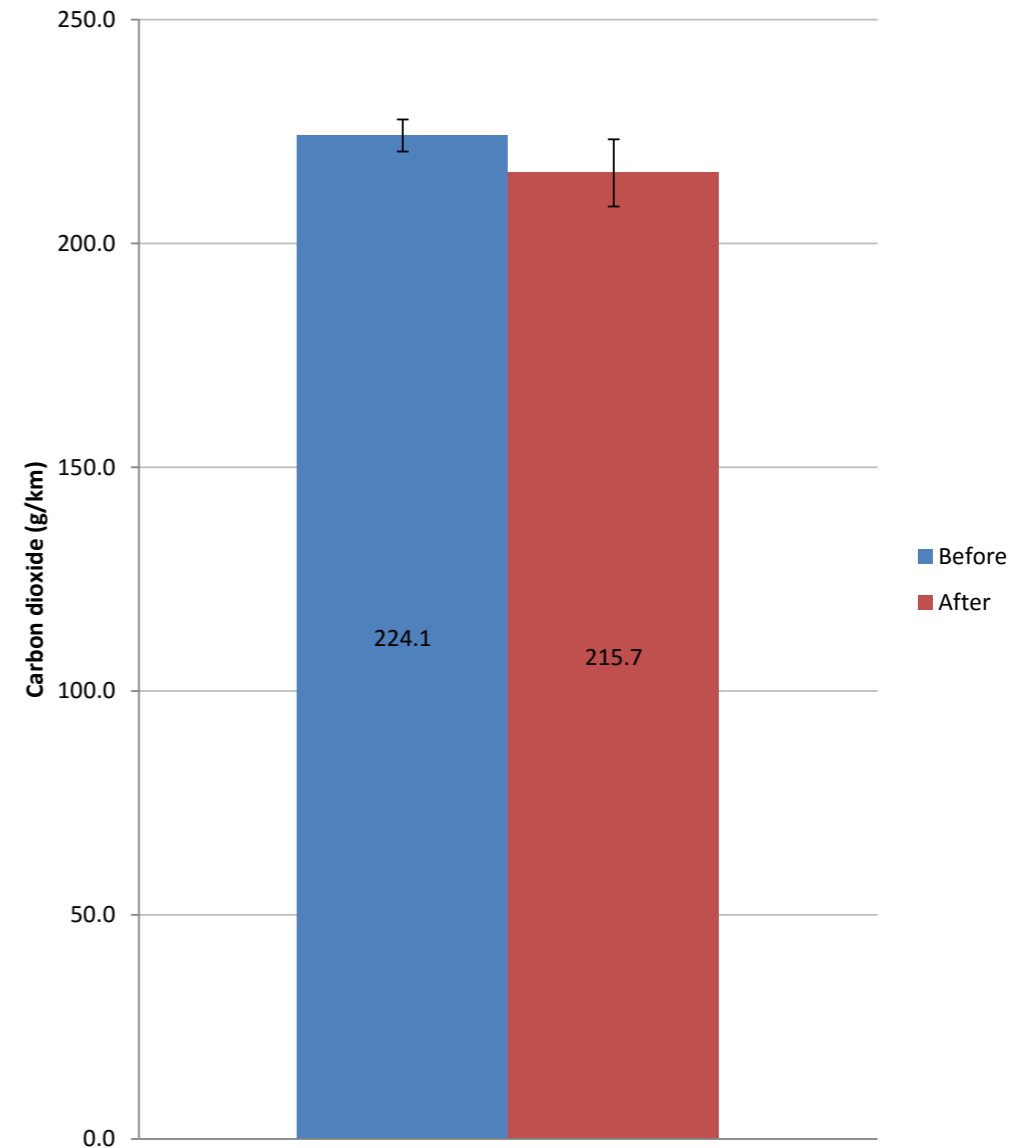
Fuel economy results

- 3.9% improvement in fuel economy over combined cycle (chart)
 - Significant @95%
- 4.6% up in urban
 - Significant @95%
- 3.5% up in rural
 - Significant @90%
- 2.2% up in motorway
 - Not significant



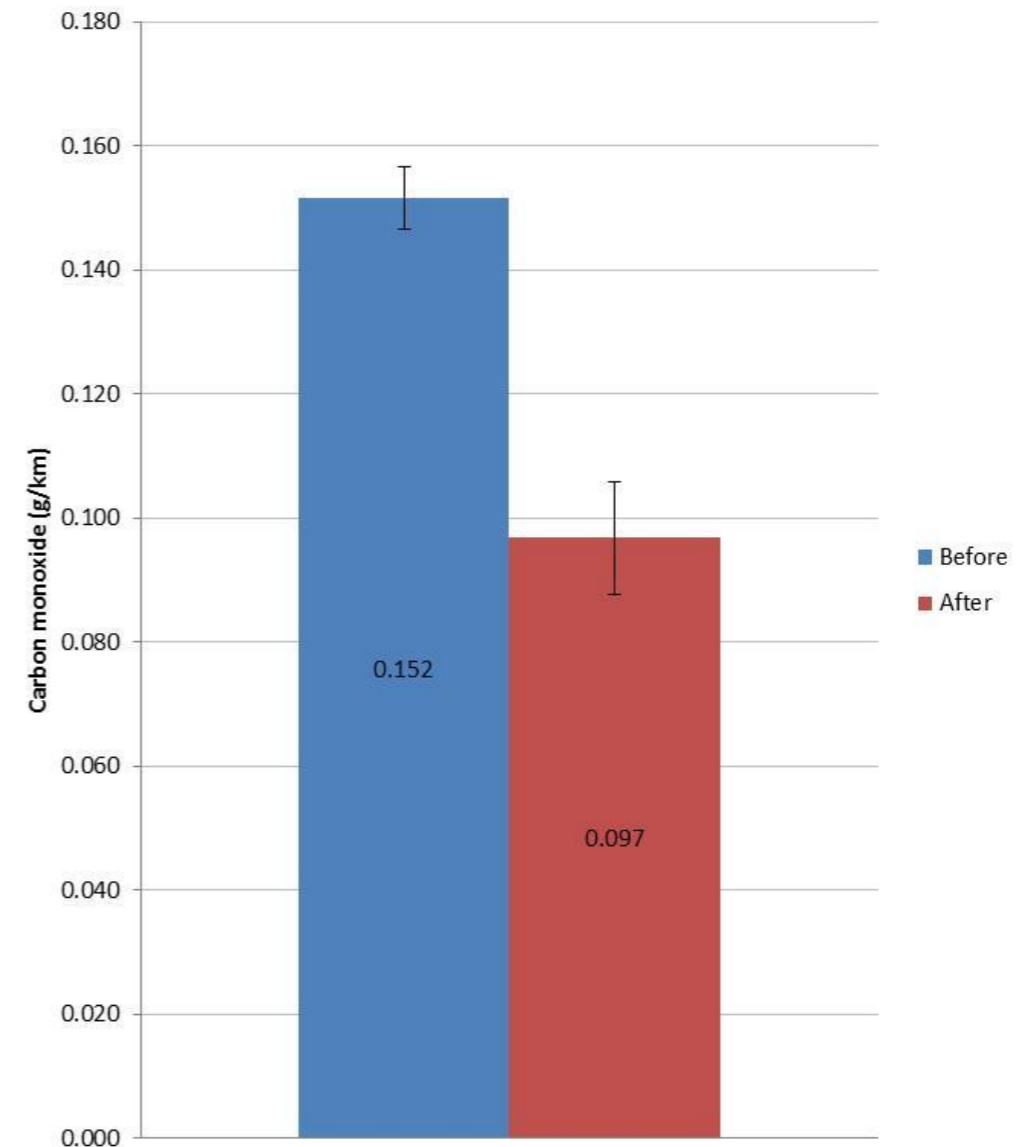
Carbon dioxide results

- 3.7% reduction in CO₂ over combined cycle (chart)
 - Significant @95%
- 4.4% down in urban
 - Significant @95%
- 3.4% down in rural
 - Significant @90%
- 2.2% down in motorway
 - Not significant



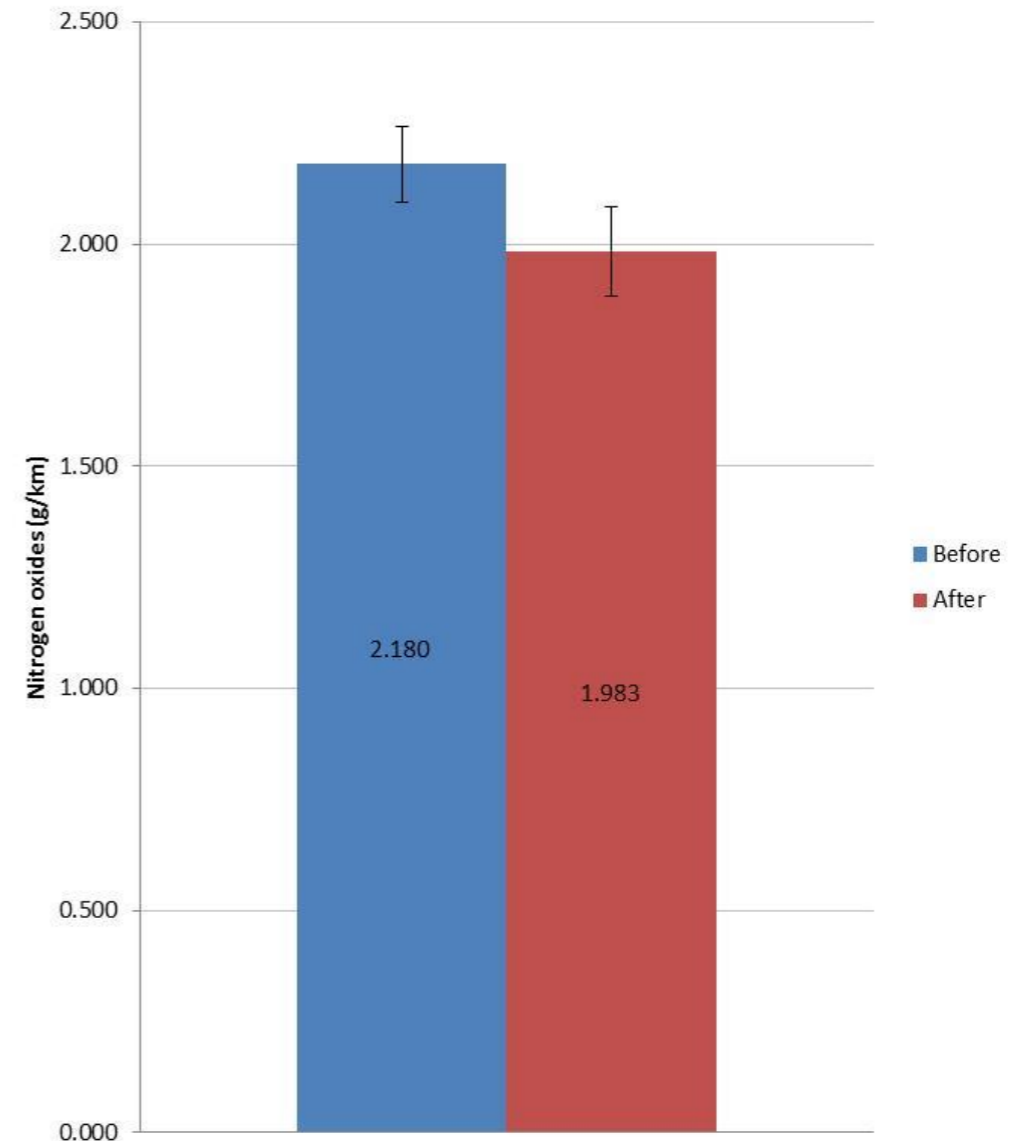
Carbon monoxide results

- 36% reduction in CO over combined cycle (chart)
 - Significant @95%
- 38% down in urban
 - Significant @95%
- 40% down in rural
 - Significant @99%
- 27% down in motorway
 - Significant @90%



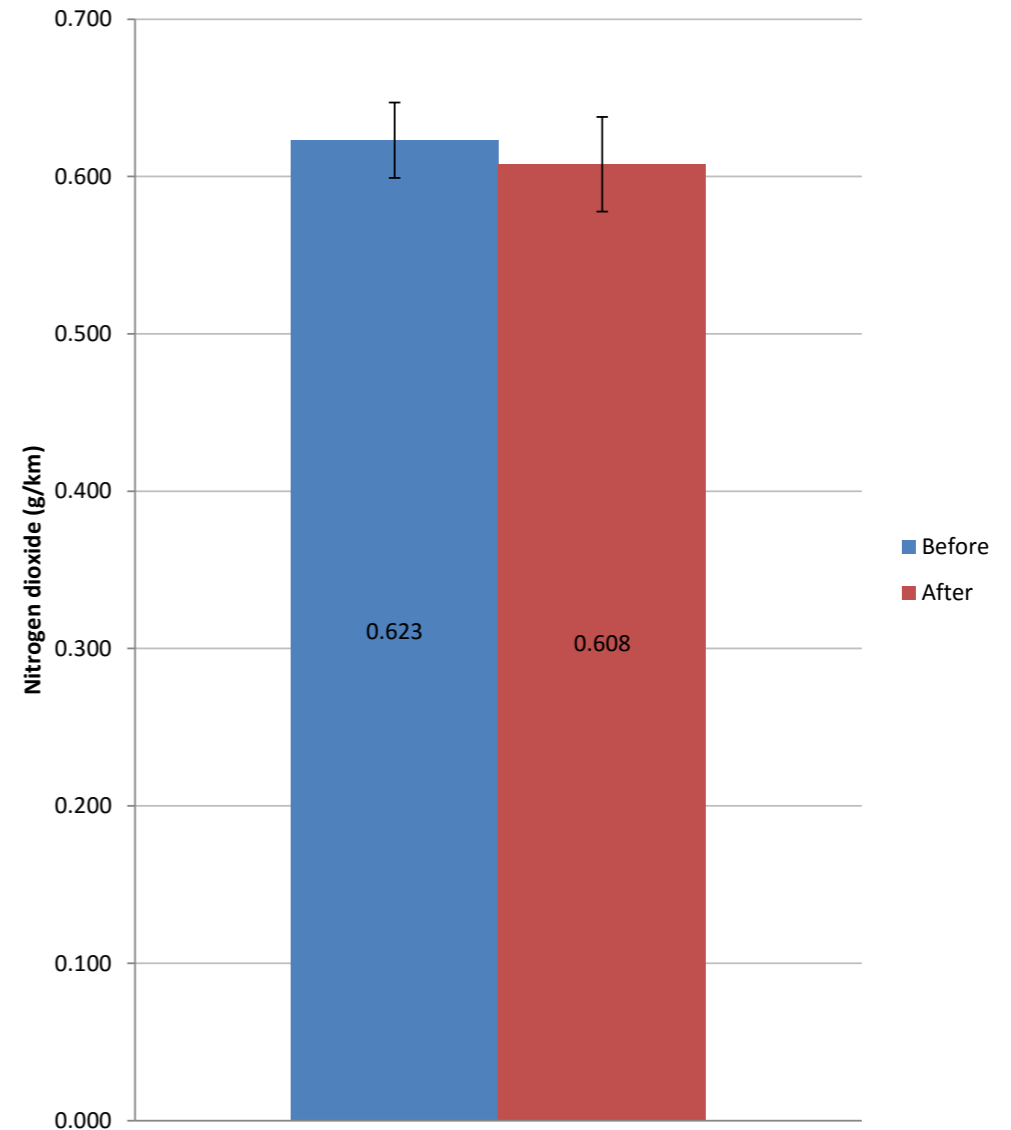
Nitrogen oxides results

- 9.0% reduction in NO_x over combined cycle (chart)
 - Significant @95%
- 5.6% down in urban
 - Significant @99%
- 13.0% down in rural
 - Significant @99%
- 9.6% down in motorway
 - Significant @95%



Nitrogen dioxide results

- 2.4% reduction in NO₂ over combined cycle (chart)
 - Not significant
- 0.7% down in urban
 - Not significant
- 4.7% down in rural
 - Significant @95%
- 3.5% down in motorway
 - Not significant



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